AD-A126 027 MM&T IMPROVED MACHINING PROCEDURES FOR DOVETAILS(U) 1/1
ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
WATERVLIET NY LARGE CALIBER WEAPON SYSTEMS LAB
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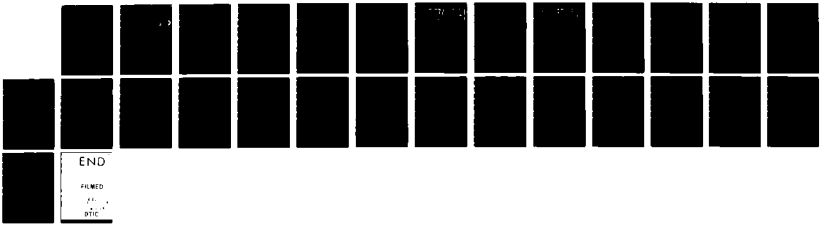

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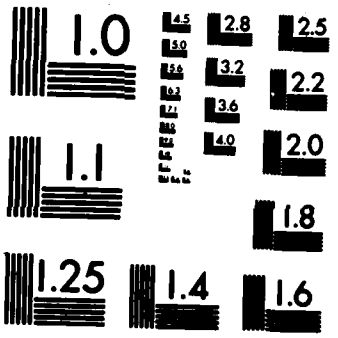

DEPARTMENT OF THE ARMY
U.S. ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
BENET WEAPONS LABORATORY, LCWSL
WATERVLIET ARSENAL, WATERVLIET, N.Y. 12189

DRDAR-LCB-SE

21 July 1980

SUBJECT: Final Technical Report

TO: Commander
U.S. Army Armament Command
ATTN: DRSAR-IRM
Rock Island, Illinois 61299

Project No: 6788043

Project Title: MM&T: Improved Machining Procedures for Dovetails

Project Officer: Gary E. Conlon

Statement of the Problem: To develop a system for producing the dovetail configuration on the 8" M201 tube assembly in a cost effective way while at the same time reducing the possibility of machining error.

Background & Introduction: Large caliber cannon have long been a very important part of this country's offensive arsenal. The fire power realized from such cannon as our 175mm M113A1 and the 8" M201 rates high in conventional weaponry. To achieve fire power of this magnitude, many difficult design and manufacturing parameters had to be established and conquered. One such condition was that of controlling recoil. Recoil, in terms of artillery weapons, refers to the reverse thrust of a weapon when it is fired. Naturally, the heavier the projectile and the more powerful the charge, the greater the recoil force. To accommodate this condition, recoil slide ways are used in the assembly. To complete this recoil system, cast steel or nodular iron hoops are shrunk on the gun barrel; dovetails are then machined into these hoops and the steel rails are then assembled. The dovetail configuration is used in this assembly to provide maximum contact area between the mating parts resulting in high strength.

The dovetail cut is the part of the operation where the hoop portion of the tube assembly is machined to the configuration required for assembling the rails to the gun tube. Figure 1 shows the hoop configuration before and after this operation is performed. The initial cuts, where the various centerline dimensions are established, as well as the actual cutting of the dovetails, (Fig. 2) are accomplished with

This project was accomplished as part of the US Army Manufacturing Technology program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques and equipment for use in production of Army materiel.

high speed steel mills. The exact size and location of the dovetails are obtained with a series of rough and finish milling cuts. The form mill used for these cuts is moved from side to side until the finish dimensions are met (Fig. 3). The number of cuts required, as well as the amount of material to be removed during the finish cuts, are determined by the actual size of each mill used. (The mill size varies depending on the number of times they are resharpened).

Approach to the Problem: The machining of dovetails is a standard practice to the metalworking industry. Over the years a variety of techniques have been tried, each offering limited success. Examples of these techniques include broaching and milling. The broaching process, while it greatly reduces the possibility of machining error by virtue of its tool geometry, requires very expensive specialty equipment that, in most cases, has very little conversion capability. Tool maintenance and capital equipment costs are comparatively high. The milling process, using high speed form cutters on the other hand, permits the use of more readily available equipment. This reduces substantially the initial start up cost. One disadvantage of using form mills is the required frequency of tool maintenance. This constantly changes the size of the mills and necessitates continual operator intervention in the operation, consequently increasing the possibility of machining error. This also increases the number of cuts necessary, thereby increasing cost.

It can be seen from the examples above that although each process shows some worthwhile advantages, each also shows some costly disadvantages. Our goal then was to develop a process that would minimize the possibility of machining error and at the same time effect a substantial cost savings. In order to accomplish this task, an evaluation of the dovetail generation process was conducted. This evaluation included a complete review of such machining parameters as, number of cuts presently required, amount of stock to be removed to complete the operation and the tolerances to be held. The size and weight of the component being machined (Fig. 4) are other factors that had to be considered in the selection of a suitable process.

Machine Selection: Initially, consideration was given to two manufacturing concepts viz., broaching and milling. An investigation, which included witnessing each of the manufacturing methods in operation, was undertaken to determine the feasibility of both concepts. As a result of this effort it was determined that either concept could be applied from the standpoint of producing acceptable components. After additional investigation and contact with representatives of both manufacturing modes, the broaching concept was dropped in favor of the more versatile milling concept. A broaching system would be extremely large and costly and would have very limited conversion capabilities should the need arise. Broach maintenance cost was another drawback.

Once it was determined that milling was the most practical means of fulfilling the requirements of this project, work began on preparing the machine specification.

Solution to the Problem: As stated earlier in this report, the problem was to develop a system for producing the dovetail configurations in a cost effective way while at the same time reducing the possibility of machining error.

Having decided on the milling concept, a variety of unique procedures were investigated to improve upon the standard high speed steel form mill process. From this investigation, it was determined that a relatively new procedure using two cross axial milling heads could be adapted to produce the dovetail portion of this milling operation (Fig. 5). The spindles of these milling heads will accommodate large diameter tool holders capable of securing indexable carbide inserts ground to the required configurations. These cross axial milling heads will not be permanently affixed to the specified machine, but rather an interchangeable system that will be mounted by means of a mechanical lifting device for the machining of the dovetails. When that portion of the operation is completed, these heads will be removed from the machine by the same lifting device and conveniently stored.

The machine, as specified in Appendix A, will be a CNC controlled milling machine with a stationary worktable and two traveling columns which will allow simultaneous machining of both sides of the tube/hoop assembly. The machining sequence for this operation will be as follows: Initially, the vertical and horizontal centerlines will be established with a series of rough and finish milling cuts on the hoops' surfaces. Once these dimensions are established a one inch slot will be milled in each side of the hoop, establishing the depth and vertical location of the dovetails; next the cross axial heads will be mounted on each milling column and the dovetails will be roughed in a single pass and finished in a subsequent pass. Following this finish pass the tube/hoop assembly will be complete at this operation and will be removed from the machine. The cross axial milling heads will also be removed at this time, preparing the machine for the next component to be loaded.

Conclusions: As a result of this effort a specification (Appendix A) was prepared for the purchase of capital equipment that will, by virtue of its design, permit the rough and finish machining of the dovetail configuration and all pertinent or preliminary operations on the tube/hoop assembly. The specified machine will replace no fewer than five (5) Ingersoll milling machines presently being used to perform these operations and will reduce the current time standard of 33.41 hours

per piece by approximately 28 hours to an anticipated standard of approximately 5 hours.

This substantial reduction in the manufacturing time coupled with the fact that we have substantially reduced the possibility of machining error, indicates that this project must be categorized as successful.

Project Officer Gary E. Conlon
GARY E. CONLON

DISTRIBUTION:

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(1) ARRCOM (DRSAR-IRM)
(2) DARCOM-IBEA (DRXIB-MT)
(2) ARRADCOM (DRDAR-LCW-SL)
(1) DARCOM (DRCMT)

Internal (At Watervliet Arsenal)

(1) Chief, Methods & Standards Section
(3) Chief, Industrial Readiness Division
(1) Chief, Prod. Plan & Control Division
(1) Chief, REARM Office
(1) Assoc Director, Benet Weapons Lab/ARRADCOM
(2) Chief, Develop Branch, Benet Weapons Lab/ARRADCOM
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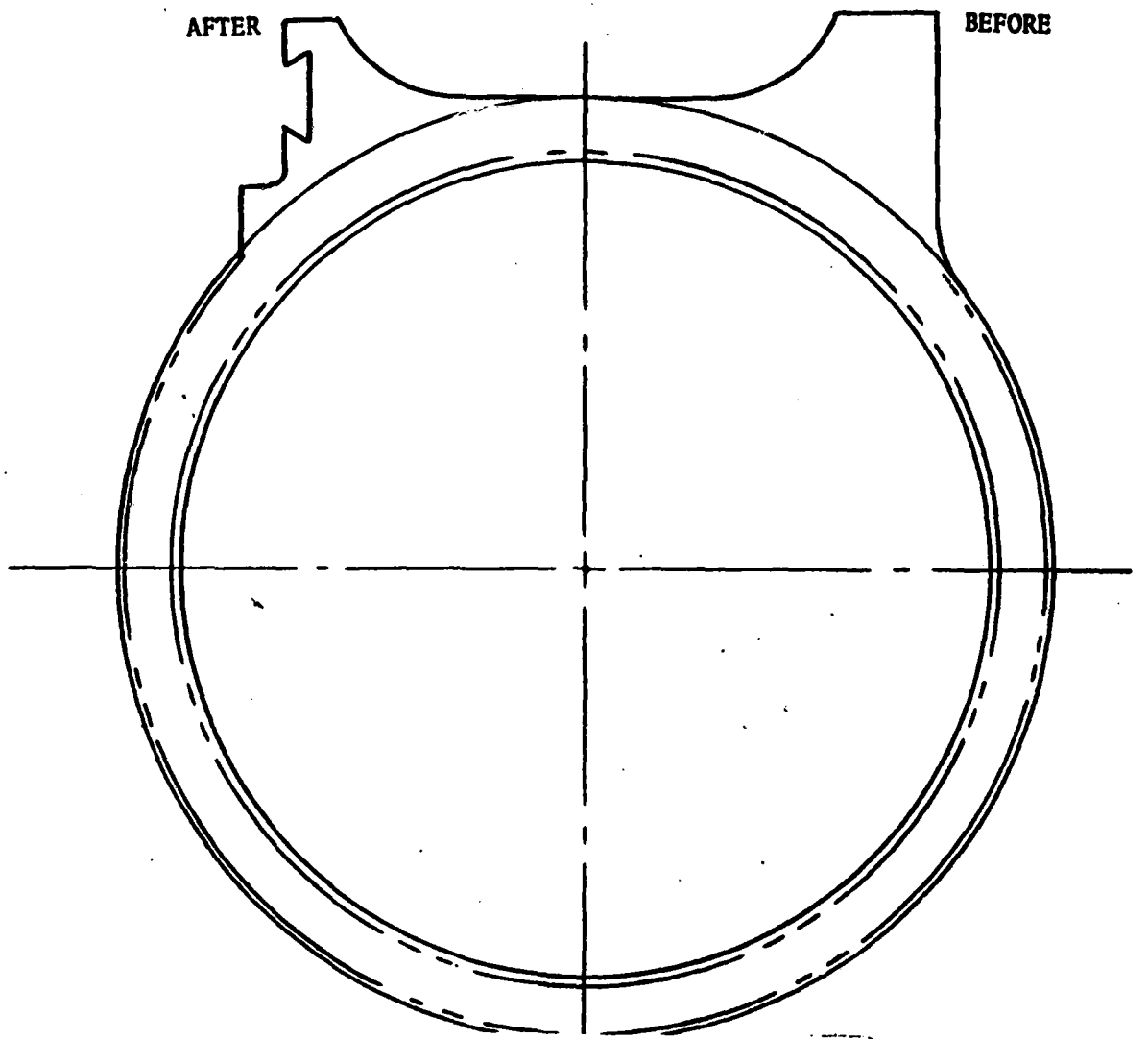

Fig. 1

HOOP CONFIGURATION BEFORE AND AFTER DOVETAIL OPERATION.

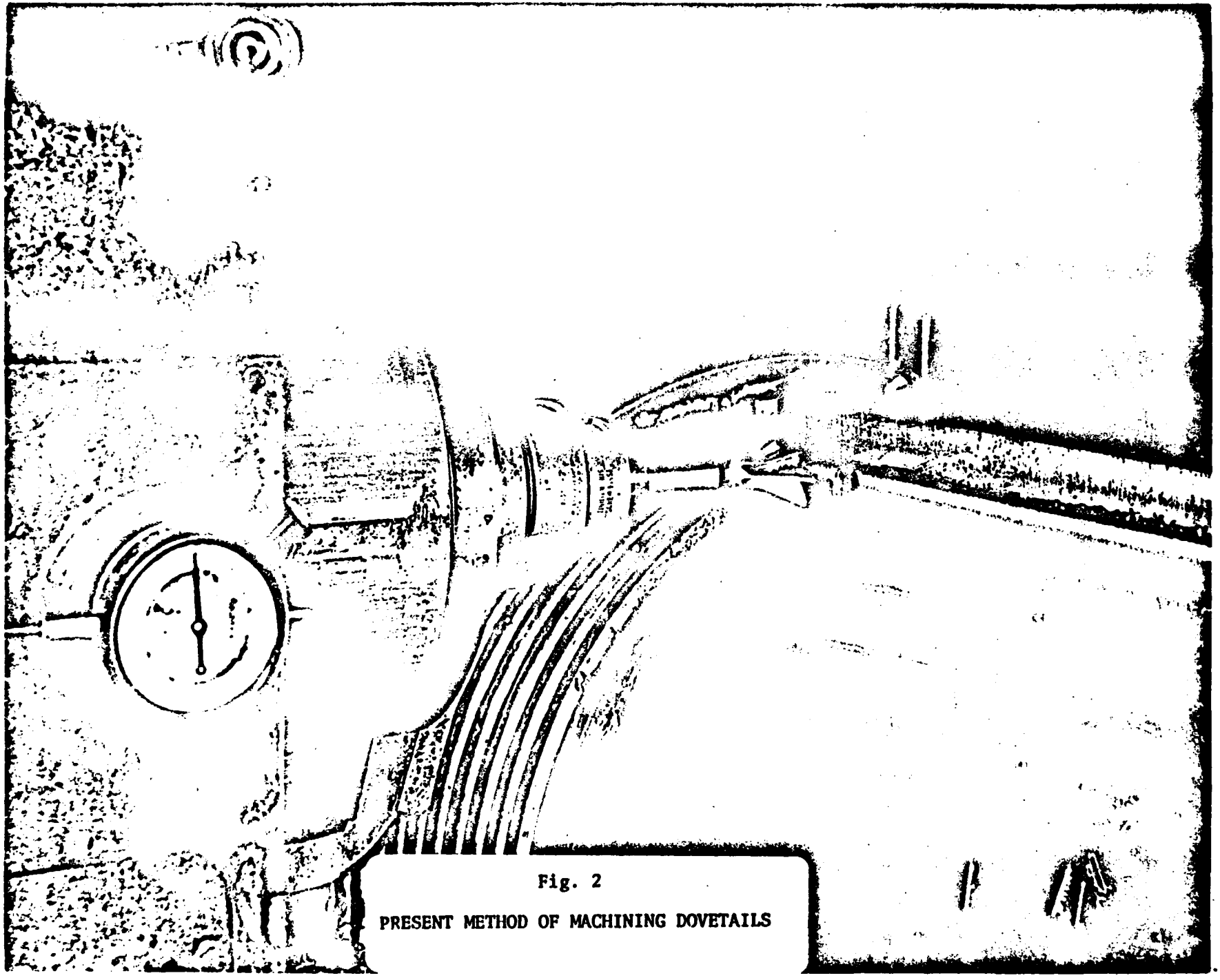

Fig. 2

PRESENT METHOD OF MACHINING DOVETAILS

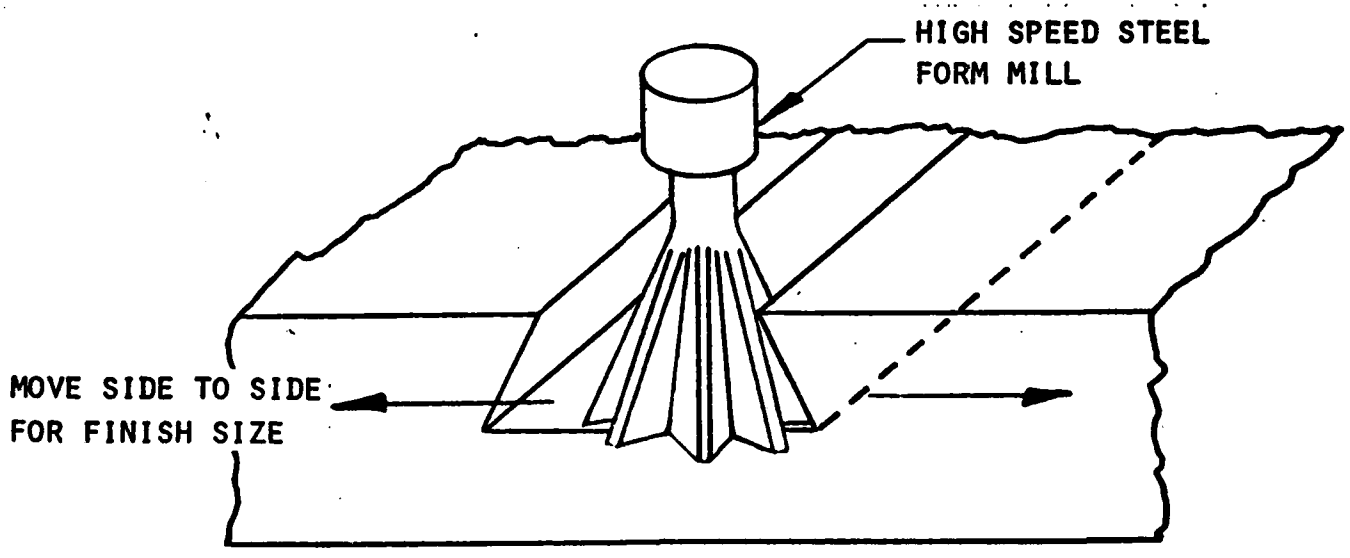

FIG. 3
FORM MILL CURRENTLY USED SHOWING SIDE TO SIDE MOVEMENT REQUIRED TO OBTAIN FINISH SIZE.

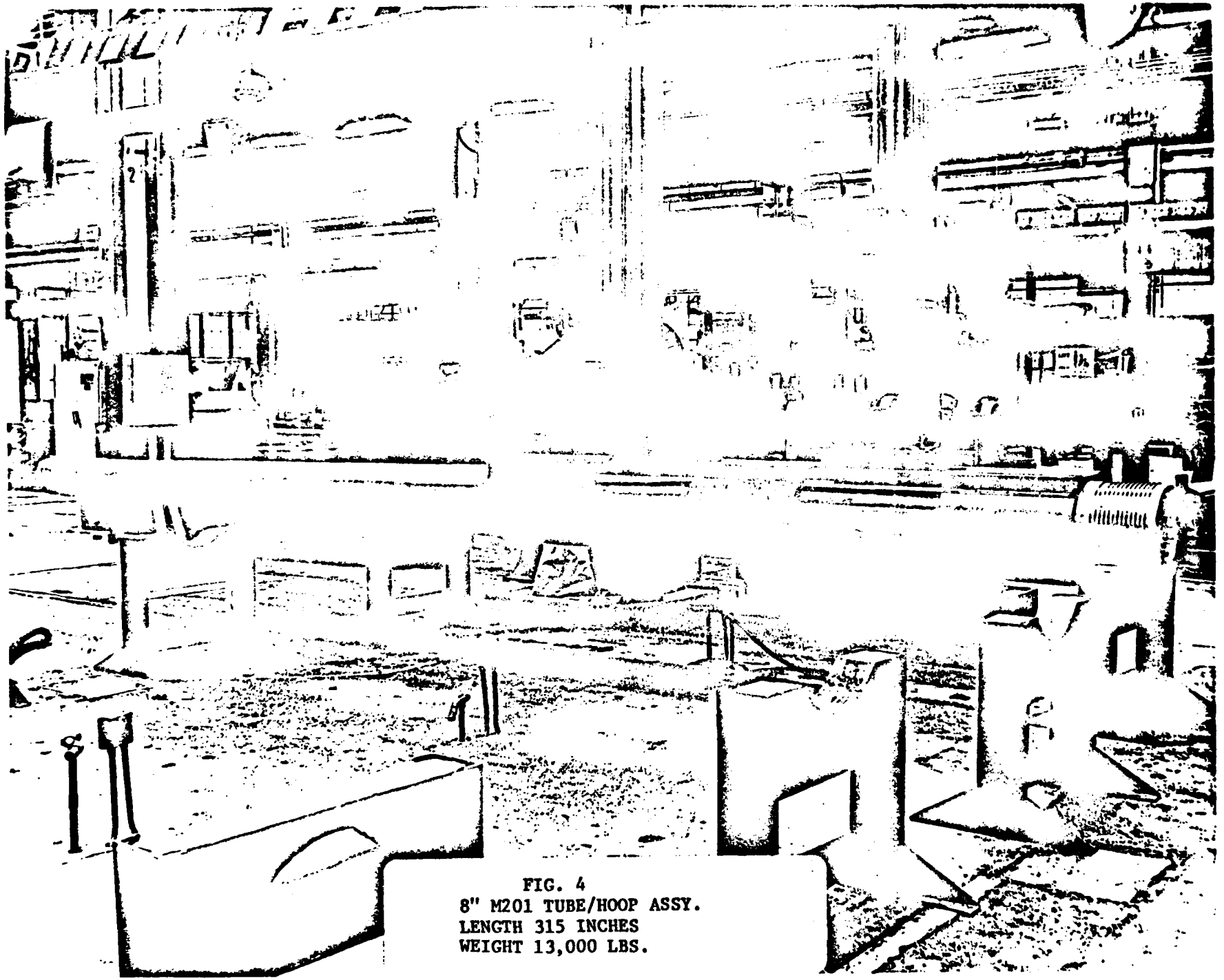

FIG. 4
8" M201 TUBE/HOOP ASSY.
LENGTH 315 INCHES
WEIGHT 13,000 LBS.

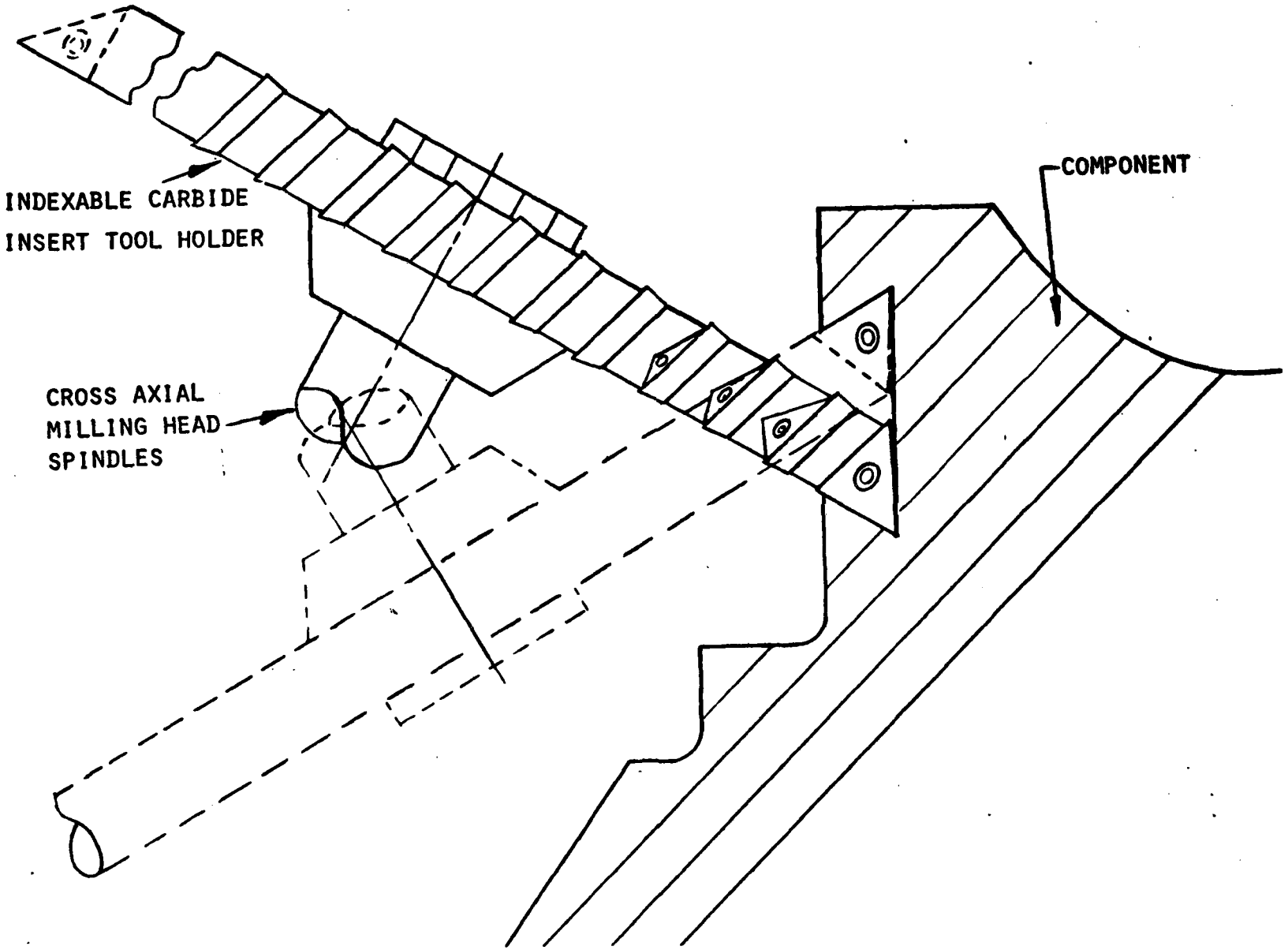

Fig. 5

PROPOSED METHOD OF MACHINING DOVETAILS

APPENDIX A

Prepared by: Gary E. Conlon
20 Sep 79
Rev. 8 Jan 80

BED TYPE TRAVELING COLUMN DUPLEX MILLING MACHINE

1. SCOPE:

1.1 Contents of this Specification: This specification includes all the requirements and/or instructions relative to the furnishing of the machine named in the specification title. Section 2 provides instructions relating to applicable standards and publications. Section 3 includes mandatory general and detailed technical requirements. Section 4 covers mandatory quality assurance provisions, testing and acceptance criteria. Section 5 provides packaging and delivery instructions and Section 6 provides instructions designed to assist offerors in making acceptable bids or proposals, and also outlines the work to be performed by the Government and/or the supplier to install the machine.

1.1.1 Description of Machine Required: The bed type traveling column duplex milling machine covered by this specification will have full 6-axis control and shall be of a size and capacity capable of fulfilling the machining requirements described in Para. 1.1.2.

1.1.2 Machining Requirements: The equipment proposed will be capable of rough and finish machining the dovetail configuration on the 8" M201 Cannon Assembly as shown in the accompanying drawing WTV Arsenal F 11578720. The total floor to floor time for this operation will not exceed five (5) hours.

1.1.3 Material to be Machined: The material to be machined in accordance with paragraph 1.1.2 will be a steel casting (see drawing D11578726) or a nodular iron casting (see drawing D11578727). These items are randomly selected for assembly on the component being machined. This presents no problem because the machining characteristics of these materials are virtually identical. The surface finish of each machined surface shall not exceed 125 RMS.

2. APPLICABLE STANDARDS AND PUBLICATIONS:

Various standards and other publications are referenced or required in Section 3 of this specification. Where they are referenced or required, they are meant to indicate a minimum level of quality, safety or performance. Except where it is indicated in this specification that no substitutions are permitted, offerors may choose to adhere to standards other than those specified, provided that the substitute represents a level of quality, safety or performance equal to or better than the one specified. Any substitutions must be clearly disclosed and explained in the offeror's statement of compliance (see 6.2).

Table of Standards and Publications Referenced or Required in this Specification

	Standard or Publication Title	Page in this Spec.
a.	National Machine Tool Builder's Association Standards	3, 5
b.	Joint Industrial Council Electrical Standards for General Purpose Machine Tools	4
c.	Title 29, Code of Federal Regulations, Part 1910 - the applicable subparts thereof and the current amendments	5
d.	Joint Industrial Council Hydraulic Standards for Industrial Equipment	
e.	OSHA, 1910.144	5
f.	MIL M9868E	
g.	MIL M38761	
h.	(NEMA) National Electrical Manufacturers Association Standards	4, 11
i.	(EIA) Electronic Industries Association Standards:	11, 12, 13, 14

RS-227-A, One-Inch Perforated Tape
RS-244-B, Character Code for Numerical Machine Control Perforated Tape
RS-267-A, Axis and Motion nomenclature for Numerical Control Machines
RS-281-A, Electrical and Construction Standards for Numerical Control Machines
RS-358-B, Subset of American National Standard Code for Information Interchange for Numerical Machine Control Perforated Tape
RS-274-D, Interchangeable Variable Block Data Positioning, Numerically Controlled Machines
EIA-RS-408, Interface between numerical control equipment and data terminal equipment employing parallel binary data interchange
EIA-RS-232-C, Interface between data terminal equipment and data communication equipment employing serial binary data interchange

NOTE: Any applicable Watervliet drawings referenced in this specification are listed in Section 1.1.2, 1.1.3, and 3.4.

Any standards adhered to in complying with this specification must be the latest issues in effect on the date of solicitation of offers, and offerors are responsible for obtaining copies. Prospective bidders should thoroughly review this specification immediately upon receipt to insure that copies are on hand prior to submitting offers.

3. REQUIREMENTS:

3.1 General Requirements:

3.1.1 Design & Engineering. The machine shall be designed and engineered in accordance with current standards recognized or adopted by the National Machine Tool Builders Association. The design and engineering shall be of the latest type but shall incorporate only concepts, systems and components which have been proved in prior use. Modifications to manufacturers' standard designs to achieve requirements specified herein are not permissible if they result in deviations from good design practice. Examples of such impermissible modifications are placing a 20HP motor in a power train designed for 10HP, or raising the headstock on a 25-inch lathe bed to achieve a 32 inch swing.

3.1.2 Materials. Materials incorporated in the construction of the machine shall be of sound and uniform quality, free from defects and shall conform in specification, heat treatment and suitability to the standards recognized or adopted by the National Machine Tool Builders Association for this type and class of equipment.

3.1.3 Construction. All parts of the machine shall be new and unused and shall be constructed as to be capable of withstanding all forces encountered during operations to its maximum rated capacity. Distortion and deflection at maximum load shall be limited to a degree consistent with retention of alignments and tolerances, and the machine shall recover from distortions and deflections at no load. The structure and assembly of the machine and its components shall be sufficiently rigid that workpiece finish and accuracy are not impaired by machine vibrations.

3.1.4 Workmanship. Workmanship throughout the machine and its equipment shall adhere to standards recognized by the National Machine Tool Builders Association for the type, class and size of the equipment.

3.1.5 Maintainability. All parts subject to wear, distortion or failure and all parts which require periodic adjustment shall be readily and safely accessible for repair, replacement or adjustment as applicable. Instructions for maintenance (see 3.1.19f) shall be clear, concise, and definite in application.

3.1.6 Interchangeability. All parts bearing the same part number shall be functionally interchangeable.

3.1.7 Location of Operator's Controls. The operator's controls shall be located in such manner that they are readily accessible to the operator from the position where he will be located to safely and efficiently operate the machine.

3.1.8 General Electrical Characteristics. The electrical system shall conform to JIC (Joint Industrial Council) Electrical Standards for General Purpose Machine Tools.

3.1.8.1 Applicable Power Source. The power source to which the machine will be connected furnishes 480 volt, 3 phase, 60HZ AC, and the machine shall be wired and equipped accordingly. In addition, the machine shall be tolerant enough of line fluctuations to operate normally at source voltages ranging from 432 to 504.

3.1.8.2 Conversion Equipment. If DC or reduced-voltage AC is required or specified for any part of the machine's operation, the necessary conversion or transformation equipment shall be furnished with the machine.

3.1.8.3 Motors. All motors shall have ball or roller bearings and shall be of the optimum type and horsepower rating to meet the intended application and usage based upon accepted engineering practice. Under normal operation of the machine throughout its specified range and capacity, no motor shall be operating at overload. All motors shall be housed in enclosures of the appropriate NEMA type for the class and severity of service, and shall be permanently lubricated, sealed and balanced. Each motor will bear an identification plate containing the identity of the manufacturer, the model, serial, input voltage, amperage, horsepower, phase, frequency and frame or mounting. All motor housings shall be indelibly marked to indicate direction of rotation.

All AC motors rated at 25HP or more shall be equipped with reduced voltage starters, and all AC motors rated at 25HP or more shall be equipped with power factor correction capacitors.

3.1.8.4 Operator Control Voltage. All controls normally actuated by the operator of the machine shall operate on 120 volts or less.

3.1.8.5 Utility Outlet. The machine shall be equipped with a dual receptacle, three wire utility outlet furnishing 120 volts AC, fused for 20 ampere power draw. This receptacle shall be mounted on an exterior surface of the machine or control and shall be easily accessible. If the machine specified is numerically controlled, a noise suppression device shall be provided to isolate the logic circuitry from electronic "noise" which may be generated by accessories or tools connected to the outlet.

3.1.9 Safety Features.

3.1.9.1 Protection of Machine Operator. Protection of the machine operator and other personnel shall be accomplished in accordance with Title 29, Code of Federal Regulations, Part 1910 -- the applicable subparts thereof and the current amendments thereto, except as otherwise noted (see 3.1.20).

3.1.9.2 Protection of the Machine. The machine shall be fully equipped with the devices necessary to prevent self-damage in the event of malfunction and/or ordinary operator negligence. Such devices include, but are not limited to, limit switches, positive end stops, overload protective devices, lubrication fail-safe, etc.

3.1.10 Identification Plate. A corrosion-resistant metal plate shall be securely attached to the machine in a visible location in the vicinity of the operator's work station. This plate shall bear, the information called for as follows, with space at the bottom for one additional line of information.

Nomenclature
Manufacturer's Name
Model
Manufacturer's Serial No.
Power Input (voltage, phase, frequency, total amps)
Government Contract No.
Date of manufacture

3.1.11 Lubrication. The machine shall be equipped with an automatic system to provide positive lubrication at the proper rate to each internal moving part where lubrication is essential to prevent damage. This system shall be interlocked to the machine controller and shall be fail safe. The fail safe system shall be designed so that movement of critical machine components cannot take place until proper lubrication pressure is available at each critical point. The reservoirs of this system shall be sized so that interval of refill shall be not less than 80 hours of machine run time. Reservoirs shall be equipped

with sensing devices to give indication to the operator when lubricant reserve has fallen to a level equivalent to four hours of machine run time. In addition, the system's reservoir locations shall be easily accessible for cleaning and flushing. All filtration devices shall be replaceable and easily accessible for cleaning to prevent passage of harmful contaminants to critical components.

Any exterior lubrication points which cannot be served by the automatic system shall be easily accessible and clearly marked as to type of lubricant required. A lubrication plate shall be permanently fastened to the machine and shall clearly indicate the type and viscosity of lubricant and the service interval for all automatic and manual lubrication reservoirs and/or fittings.

3.1.12 Hydraulic System. When a hydraulic system of any type is provided or specified, it shall be appropriately sized and powered for the intended application, and shall conform to JIC Hydraulic Standards for Industrial Equipment. The system shall incorporate cleanable or replaceable filtration devices to insure fluid cleanliness. Reservoirs will be equipped with easily visible gages to indicate fluid level. If duty cycle of the system under maximum usage will cause the hydraulic fluid to exceed 120°F in temperature, a suitable air-cooled, recirculating water-cooled or refrigerated heat exchanger shall be provided to maintain fluid temperature at or below this level. Complete overpressure protection will be included. System pressure in any hydraulic device shall be as low as is practical for the intended application. In any system which utilizes hydraulics to produce thrust or direct linear motion, anti-surge devices or circuits shall be incorporated to insure uniformity of motion under varying loads.

NOTE: All reservoirs shall be easily accessible for cleaning and flushing system.

3.1.13 Painting. All exterior machine surfaces shall be painted except where bright metal is required for machine function or to otherwise adhere to the requirements of this specification. Paint shall be applied in such a manner and shall be of proper quality to afford protection throughout the normal life of the machine. Paint color and finish shall be machine tool gray and semi-gloss. Dangerous and caution areas shall be painted yellow in accordance with OSHA, 1910.144.

3.1.14 Machine Hold-Down and Leveling. The machine base shall be provided with sufficient and properly located holes for positive hold-down when the machine is operating at its maximum rated capacity. In addition, the contractor shall provide with the machine a complete set of hold-down hardware for each mounting hole, plus two spare sets. The hold-down hardware shall include bolts of the hollow jack-screw type to permit leveling and hold-down on the same axis. These bolts shall be long enough to permit insertion of a two-inch thick steel plate between the machine base and the floor surface.

NOTE: All hold-down hardware shall be delivered 30 days prior to shipment of the machine.

3.1.15 Threads. All threaded parts shall be in either the inch or metric system, and shall be uniform within one or the other system throughout the machine.

3.1.16 Gears. All gears used in the machine and its components shall be machined in either the inch or metric system, and shall be uniform within one or the other system throughout the machine.

3.1.17 Feed Dials. Feed dials, if used, shall be of the electronic digital type, inch and metric switchable. Units of stock removal or slide movement shall be not more than .001 inch and .025MM. Means shall be provided to void one of the scales while the other is in use. Digit sizes shall be such that increments may be easily read.

3.1.18 Handwheels. Where power feed and/or rapid traverse of a machine component is provided or specified, associated handwheels or cranks, if any, shall not rotate when power feed or rapid traverse is engaged.

3.1.19 Technical Data. Data shall be furnished as follows and shall be in the English language. Numbers of copies shall be as specified below for orders of a single machine. For orders of more than one machine, a single copy per machine shall suffice, delivered according to the schedules indicated below for each machine, except where programming manuals are required (see Item i, below). Only two programming manuals are required regardless of the number of machines ordered.

a. Catalog of available tooling and optional accessories -- to be furnished 120 days prior to scheduled delivery of machine (2 copies).

*b. Installation and foundation drawings -- to be furnished 120 days prior to scheduled delivery of machine (one reproducible copy).

*c. Electrical and hydraulic schematics -- to be furnished 60 days prior to scheduled delivery of machine (one reproducible copy).

*d. Lubrication diagram or instructions -- to be furnished at time of delivery (2 copies).

e. Operating instructions -- to be furnished at time of delivery (2 copies).

f. Maintenance and step by step trouble-shooting manual for all machine systems, to be furnished at time of delivery (2 copies).

*g. Catalog of machine parts and subassemblies not produced by the machine manufacturer, including, as a minimum, the nomenclature of the part, the supplier of the part and the supplier's catalog or stock number. This catalog will be furnished at time of delivery (2 copies).

h. Complete assembly drawings to identify all parts -- to be furnished 60 days prior to scheduled delivery of machine (2 copies).

i. Programming Manuals, 2 copies (where an NC machine is offered or specified) -- to be furnished 60 days prior to initial delivery.

*NOTE: Items marked (*), in addition to being furnished as specified above, shall also be furnished on 35mm microfilm mounted in standard aperture cards. Each aperture card shall be clearly imprinted or typed to identify the subject of the microfilm. Two complete microfilm sets are required, and shall be furnished at time of machine delivery, marked to the attention of the Arsenal's contract administrator. All technical data shall be packaged to insure arrival at the Arsenal in good condition. (Ref: MIL-M-38761 and MIL-M-9868E).

3.1.20 Noise Levels. Noise levels shall be measured during the operational test (see 4.4.1) and shall be measured at any or various times during this test at the discretion of the Contracting Officer or his appointed representatives. Noise levels at the vicinity of the machine shall not exceed 85 decibels when measured by a properly calibrated sound level meter set for "A" scale and slow response. "Vicinity of the machine" is further defined as an imaginary line completely surrounding the machine at a distance not exceeding one meter from the nearest point on the machine. The 85 decibel limit is absolute and shall apply at the operator's station, even if inside the one meter envelope. Techniques such as sound level averaging or exposure time weighting shall not be used in meeting this requirement.

Any shields, baffles, enclosures or other devices required to bring the machine into conformance with this noise level requirement shall be furnished by the contractor. Any such devices shall not interfere with the proper operation of the machine and shall be designed to preserve the visibility needed for safe operation.

3.1.21 Machine Start-up and Testing. Upon being notified by the Contracting Officer that the machine has been installed and made ready for start-up, the contractor shall furnish a competent service engineer to place the machine in proper operation. The machine will not be activated and run without the attendance of the contractor's service engineer. In addition to machine start-up, the service engineer will be responsible for performance of all acceptance tests specified in Section 4 of this specification, and shall remain until the tests are complete.

3.1.22 Training Required. The supplier shall provide training of Arsenal personnel. The nature and extent of training provided shall depend upon whether the machine specified or offered is equipped with Numerical Control, and shall adhere to the applicable areas of the following table. Oral and written materials shall be in English.

Type of Training	No. of Persons	Hours of Training - Per Person	
		Non - Nc Machines	NC Machines
Machine operation	2	8	24
Mechanical maintenance	2	8	24
Hydraulic maintenance (if applicable)	2	8	24
Electrical maintenance	2	8	8
Electronics (control)Maint.	2	N/A	40
Programmer training	2	N/A	40

The following notes shall apply to the above table:

a. For all types of training, the associated technical data (see 3.1.19) shall be on hand at the time of instruction, and its use and interpretation shall be covered during the training.

b. For orders of a single machine tool, the number of persons to be provided with each type of training shall be as indicated above. For orders of more than one machine tool, training in machine operation shall be provided for two persons per machine, and all other training shall be provided for two persons only per type of training.

c. Training in machine operation, mechanical maintenance, hydraulic maintenance and electrical maintenance shall be given on-site at Watervliet Arsenal at the time of machine start-up and testing, and shall be given during normal working hours which are Monday through Friday from 7:30AM to 4:00PM. For orders of more than one machine tool, training in machine operation shall be given at start-up of each machine, and training in mechanical, hydraulic and electrical maintenance shall be given at start-up of the first machine.

d. Training in electronics (control) maintenance and programming (for NC machines) shall be made available on at least four occasions each during a time period of from 60 days prior to initial delivery to two years after initial delivery with one session of each type being available prior to delivery. The Arsenal shall reserve the right to choose any two of the four available sessions of each type, and to train one person at each chosen session. This training shall be formal classroom training and shall be held off-site at a location within the U.S., arranged by the supplier. Schedules for each training session shall be forwarded to the Administrative Contracting Officer (ACO) at least 60 days in advance and shall include appropriate application forms and registration instructions.

3.1.23 Repair/Replacement Parts Availability. The supplier of the machine shall guarantee the availability of proprietary repair/replacement parts for a period of not less than 10 years following date of machine delivery.

3.1.24 Pneumatic Requirements. If air is required for any machine operation or function, a suitable dryer and filter shall be supplied. Available high pressure air supply is 80 PSI.

If any machine function requires air supply in excess of 80 PSI, the equipment needed to supply the higher pressure shall be supplied with the machine.

3.2 Detailed Requirements: The machine shall consist essentially of and not be limited to the following: A base, worktable, two milling columns with individual drives, lubrication system, solid state electronic controls, a chip removal system and a complete carbide tooling package for each milling column.

3.2.1 Base: The base shall be a heavy box type casting of close grain cast iron or steel weldment capable of providing maximum support for the worktable. All corners shall be rounded, free of sharp edges and protrusions for safe operation. The base shall be well proportioned and adequately ribbed and braced at frequent intervals to provide maximum rigidity and strength to maintain the original alignment and resist deflection, distortions and undesirable vibrations under continuous maximum load. Hold-down and leveling requirements are covered in 3.1.14.

3.2.2 Worktable: The worktable shall be of sufficient size to adequately support the workpiece and be so designed to be free from any warpage and have minimum wear over a long period of use.

The top surface of the worktable shall be machined true, flat and parallel to the horizontal axis of the spindles within .001" of its full length and width. Also, the top surface shall be provided with accurately machined tee-slots running longitudinally and perpendicular with the horizontal axis of the spindles the full length of the table.

The worktable will be a stationary unit mounted on the machine base or as an integral part.

3.2.3 Milling Columns: This machine shall be equipped with two (2) traveling milling columns. Each column will have its own drive and be so situated that simultaneous machining of both dovetails will occur. Each column will house the milling spindles that will, through adapters, hold the various milling cutters that are required for the specified work to be performed. Column configuration must be such that the operator can safely and easily change adapters and tools as required. These columns will not only travel longitudinally but also cross-axially (transversely). The performance characteristics required of the milling columns will be found in paragraph 3.3.

3.2.3.1 Should this machine be equipped with multi or special milling heads that must be mounted and/or dismounted on the milling columns during the machining operation, a suitable means of handling or assisting the operator in handling and storing these heads must be provided. Also, should this type of system be employed, the contractor must show proof that he has provided systems of this type and design in the past.

3.2.4 Lubrication System: See paragraph 3.1.11.

3.2.5 CNC Control System: The numerical control system shall be a CNC. The CNC control shall perform all the functions required to control the machine being purchased. The processor will provide for features and options such as; interpolation, tape and program edit, alphanumeric readout display, program storage, software requirements and axis calibration.

3.2.5.1 Construction of control system in accordance with EIA Standard RS-281-A, Electrical and Construction Standards for Numerical Control machines.

3.2.5.2 Design of cabinet enclosure in accordance with NEMA 1 Standards.

3.2.5.3 Input media to conform to EIA Standard RS-227-A, one inch perforated tape.

3.2.5.4 Tape code input to conform to EIA Standard RS-244-B, Character Code for Numerical Machine Control Perforated Tape and RS-358-A, Subset of American National Standard Code for information interchange for numerical machine control perforated tape.

3.2.5.5 Tape format shall be in accordance with EIA Standard RS-274-C, Interchangeable Perforated Tape Variable Block Format for positioning numerical control machines.

3.2.5.6 Axis and motion nomenclature shall be in accordance with EIA Standard RS-267-A, Axis and motion nomenclature for numerical control machines.

3.2.5.7 Tape Reader (minimum requirements)

1. 150 CPS photo-electric reader bi-directional
2. Tumble box, 50 ft. capacity
3. Tape reels 7-1/2 in. dia.

3.2.5.8 Alphanumeric Readout

1. Located at the control cabinet; minimum 250 alphanumeric characters.
2. The readout must be capable of displaying: axis position, active block, buffer blocks, offset tables, MDI entries, control status, MTB machine status messages and diagnostic routines for maintenance.

3.2.5.9 Control System Features

1. Linear and circular interpolation, switchable plane
2. Inch/metric switchable (G code)
3. Automatic acceptance of both EIA tape codes RS-244-B and RS-358-A
4. Absolute/incremental programming, switchable (G code)
5. Feed rate programmed in IPM/MMPM
6. RPM programming
7. Leading zero suppression

8. Resolution .0001 inch/.001 MM

9. Departure commands, incremental or absolute +500.0000 in./ +5000.000mm

10. Part program storage - minimum equivalent 500 ft. of tape.

11. Program stop/optional, stop/block, delete

12. Dry run mode

13. Sequence number search - forward and reverse

14. Parity check

15. Single block buffer storage

16. Programmable dwell

17. Mirror image (X and Y axis)

18. Program edit (add, modify or delete)

19. Zero shift (relate program zero to machine zero)

20. Absolute machine position display (simultaneous)

21. Programmable lockout of manual feed rate override

22. Cutter diameter compensation (right, left, on and off)

23. Canned cycles (drill, deep hole drill, tap, bore, etc.)

24. Dual tool length offsets (20 min)

25. Ability to incorporate parametric sub-routines

26. Dual set-up capabilities

27. Logic retention in case of power failure

28. Diagnostic routines for maintenance

29. Ambient temperature requirement: 50°F - 120°F

30. Solid state control - machine interface*

*NOTE: The intent of this requirement is to utilize the machine tool and the control interface to the extent that most or all of the interconnecting wiring is accomplished by the supplier and need not be redone upon installation at the Arsenal. An approach wherein the control interface is mounted directly on the machine tool and permanently wired in or which makes use of "quick disconnect" plugs will be an acceptable alternative.

3.2.5.10 Operator's Console - Minimum Features: The operator's console shall be conveniently located at the breech end of the gun tube when fixtured on the worktable, and so situated that the operator will have a clear view of the actual machining operation while standing at the console.

1. Absolute position readouts for all axes
2. Feedrate override (0-120% minimum)
3. Speed override (50-120%)
4. Operating modes (manual/auto/single/Manual Data Input)
5. Manual resolver jog - infinitely variable over feed rate range and rapid traverse
6. Incremental Jog - .001", .01", .1"
7. Alphanumeric keyboard for manual data input
8. Emergency stop
9. Feedhold
10. Cycle start - stop
11. Spindle on-off

3.2.6 Chip Removal System: The machine shall be equipped with all necessary equipment required to remove the chips created by the machining operations. This system shall remove the chips to a point(s) where they can be efficiently and easily disposed of. The disposal port(s) for removing these chips from the machine must be a minimum of 42 inches and a maximum of 65 inches off the floor to allow for government furnished chip gondolas to fit under the port(s). Subject disposal port(s) must dump at the end of the machine opposite the operator's station. See section 3.2.5.11.

3.2.7 Tooling Package: This machine will be supplied with one complete set of carbide tools, cutters and adapters for each milling column. The carbide inserts used in these tools and cutters will be of the indexable variety. Initial selection of carbide grades to be used will be left to the contractor's discretion. This tooling package will be capable of performing all required machining operations, within the required floor to floor time, for which subject machine is intended.

3.3 Performance Characteristics:

Spindle Drive: Each spindle will be independently driven by a DC motor of 25 HP min.

Spindle RPM: 50 or less to 1200 or more, infinitely variable.

Length of Travel per Column: Longitudinal stroke - 190" min.

Vertical stroke - 27" min.

Transverse stroke - 24" min.

Feed Rates: 0.5" or less to 100" or more, infinitely variable.

Rapid Traverse: 200 IPM min. (all axes)

3.4 Fixturing: The present method of fixturing the gun tube consists of two (2) u-shaped cradles, each with a clamping strap that will go over the tube. One cradle is located at the extreme breech end of the tube and the second is located at a point approximately 190 inches up the tube. Reference fixture drawing Wvt. Arsenal F7309254-T22D. Providing the configuration of the machine covered by this specification does not preclude the efficient and safe manual loading and clamping of subject tube, the above mentioned fixturing can be utilized. In the event that operator access to the fixturing is not available, an alternate method must be provided at the contractor's expense.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection. The supplier shall be responsible for the performance of all inspections specified herein. However, the Government reserves the right to insure that the inspections performed by the supplier are fully adequate to confirm the machine's conformance to all requirements of this specification.

4.2 Preliminary Acceptance Inspection. The machine shall be subjected to, and pass, a preliminary acceptance inspection at the builder's plant prior to being shipped. Preliminary acceptance inspection shall consist of the examination specified in 4.3 and the tests specified in 4.4. The date of inspection shall be furnished to the purchasing contracting officer at least ten (10) days prior to inspection so that if he deems it necessary, his representatives may be present to witness the tests. Upon completion of preliminary acceptance inspection, the supplier shall certify in writing to the purchasing contracting officer that the complete inspection has been performed and that the machine conforms to all specified requirements. This certification shall be required whether or not Government representatives are present for the inspection.

4.3 Examination. Subject machine and equipment shall be visually examined for appearance, workmanship, maintainability and completeness, including all specified systems, accessories, markings and safety devices.

4.4 Testing: The machine described in this specification must be capable of passing an operational test 4.4.1, and a final acceptance test 4.4.2.

4.4.1 Operational Test: The machine shall be operated under manual control with spindle turning at no load for not less than 30 minutes for an initial warm-up period. During this period, proper operation of all manual controls, motors, adjustment mechanisms and accessories shall be verified.

Upon completion of the warm-up period and check of manual controls, the machine shall be cycled under numerical control to assure operation of each programmable function for a period of one hour. A program shall be prepared by the vendor and submitted to Watervliet for approval prior to use. This operational test is intended to check operability only, no cutting tests are part of this requirement. The operational test tape shall include, as a minimum, changes in spindle speeds and feed rates, fixed cycles, rapid traverse of all slides and simultaneous movements of all slides. The operations to be performed to check programmable operations under tape control may be performed in any sequence convenient to the manufacturer. This test will be performed at Watervliet Arsenal after machine has been completely installed.

4.4.2 Final Acceptance Test: The final acceptance test will be performed at Watervliet Arsenal. Subject test will consist of setting up and machining four (4) 8" M201 cannon assemblies to the configuration

and tolerances shown in Drawing F11578720. Fixturing will be provided and installed by Watervliet Arsenal. Acceptance will require the successful machining of the dovetail operation on four consecutive cannon assemblies within five (5) hours or less per assembly. After two assemblies have been machined all inserts will be randomly indexed. The last two assemblies will then be machined complete. Final acceptance and testing will be under the supervision of the contractor's service engineer and Arsenal personnel.

5. PRESERVATION, PACKAGING AND DELIVERY. The supplier shall utilize standard commercial methods of preservation and packaging appropriate for machine tools and acceptable to commercial carriers. As a minimum, all areas susceptible to damage from exposure to the elements shall be preserved and/or packed to prevent such damage. The machine and equipment shall be blocked, braced and skidded to prevent damage during transport and to facilitate handling, loading and unloading. The supplier shall be responsible for insuring that the machine and equipment are delivered to Watervliet Arsenal in good condition and shall retain this responsibility until the machine and equipment are offloaded at Watervliet Arsenal by Arsenal personnel.

NOTE: If any special lifting devices are recommended by the supplier to facilitate handling, such devices shall be shipped with the machine. They will be returned to the supplier upon completion of use.

6. INSTRUCTIONS TO OFFERORS:

6.1 Descriptive Literature. Offerors shall submit, in triplicate, brochures, photographs, illustrations, drawings and/or narratives which clearly indicate that the design, construction and operating features of the machine and equipment offered will meet all the requirements set forth in Section 3 of this specification. Literature displaying more than one model or size machine shall be clearly marked so as to indicate the model or size being offered. Offers which do not present sufficient information to permit complete technical evaluation by the Government may be rejected.

6.2 Statement of Compliance. In addition to the descriptive literature in 6.1, offerors must indicate on a paragraph-by-paragraph basis whether or not they comply with the Technical Requirements in Section 3, the Quality Assurance Providions in Section 4 and the Preservation, Packaging and Delivery requirements in Section 5 of this specification. For example:

3.1.1 thru 3.2.4 - we comply.
3.2.5 - we take exception and propose instead - - - - etc.
3.2.6 thru 3.2.11, - we comply.

For exceptions taken, the proposed alternative must explain in detail how it equals or exceeds the specified requirement in function and suitability.


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